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Time Analysis for Project 2

**Points within a Circle**

|  |  |  |  |
| --- | --- | --- | --- |
| n\* | Running Time (in Milliseconds) | | |
| Graham Scan | Jarvis March | Quickhull |
| 10 | 0 | 0 | 0 |
| 100 | 0 | 0 | 0 |
| 1,000 | 0 | 0 | 0 |
| 10,000 | 7 | 2 | 13 |
| 100,000 | 61 | 51 | 237 |
| 1,000,000 | 516 | 788 | 3,650 |
| 2,000,000 | 1,005 | 1,670 | 7,702 |
| 4,000,000 | 2,009 | 3,551 | 16,530 |
| 8,000,000 | 4,171 | 8,679 | 40,654 |

**Points on a Circle**

|  |  |  |  |
| --- | --- | --- | --- |
| n\* | Running Time (in Milliseconds) | | |
| Graham Scan | Jarvis March | Quickhull |
| 10 | 0 | 0 | 0 |
| 100 | 0 | 0 | 0 |
| 1,000 | 0 | 1 | 6 |
| 10,000 | 3 | 20 | 62 |
| 100,000 | 32 | 184 | 599 |
| 1,000,000 | 289 | 1,854 | 6,141 |
| 2,000,000 | 599 | 3,645 | 12,210 |
| 4,000,000 | 1,149 | 7,848 | 23,827 |
| 8,000,000 | 2,325 | 14,939 | 47,820 |

**Points within a Rectangle**

|  |  |  |  |
| --- | --- | --- | --- |
| n\* | Running Time (in Milliseconds) | | |
| Graham Scan | Jarvis March | Quickhull |
| 10 | 0 | 0 | 0 |
| 100 | 0 | 0 | 0 |
| 1,000 | 0 | 0 | 0 |
| 10,000 | 6 | 2 | 7 |
| 100,000 | 68 | 18 | 37 |
| 1,000,000 | 544 | 177 | 292 |
| 2,000,000 | 1,040 | 377 | 484 |
| 4,000,000 | 2,048 | 1,325 | 990 |
| 8,000,000 | 4,039 | 1,977 | 2,020 |

**Points within a Triangle**

|  |  |  |  |
| --- | --- | --- | --- |
| n\* | Running Time (in Milliseconds) | | |
| Graham Scan | Jarvis March | Quickhull |
| 10 | 0 | 0 | 0 |
| 100 | 0 | 0 | 0 |
| 1,000 | 0 | 0 | 0 |
| 10,000 | 6 | 0 | 3 |
| 100,000 | 56 | 11 | 41 |
| 1,000,000 | 538 | 99 | 106 |
| 2,000,000 | 1,057 | 188 | 213 |
| 4,000,000 | 2,205 | 145 | 426 |
| 8,000,000 | 4,333 | 483 | 842 |

**Asymptotic Time Complexity**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Running Time Complexity | | |
| Graham Scan | Jarvis March | Quickhull |
| Best Case | O(nlogn) | O(n) | O(n) |
| Average Case | O(nlogn) | O(nlogn) | O(nlogn) |
| Worst Case | O(nlogn) | O(n2) | O(n2) |

**Does my empirical analysis match my theoretical analysis?**

* Points within a Circle
  + This one was very interesting. It matched my theoretical analysis. The Graham Scan was by far the most efficient (since it always runs at O(nlogn)). The Quickhull took the longest by a long shot, since it was operating at its worst case (with a runtime of O(n2)). Lastly, the Jarvis March was in between them, operating closer to the Graham Scan than the Quickhull. This means that its runtime must’ve been O(nlogn), especially since it was much closer to Graham Scan’s time than Quickhull’s time.
* Points on a Circle
  + This one was similar to Points within a Circle. It matched my theoretical analysis. The Graham Scan was by far the most efficient (since it always runs at O(nlogn)). The Quickhull took the longest by a long shot, since it was operating at its worst case (with a runtime of O(n2)). Lastly, the Jarvis March was in between them, operating almost in the middle but slightly closer to the Graham Scan than the Quickhull. This must have been a slightly worse case for Jarvis March, since it operated a little worse than it did during Points within a Circle. It still fits with O(nlogn), however.
* Points within a Rectangle
  + Yes, this matches my theoretical analysis. The Graham Scan took longer than both the Jarvis March and Quickhull. Jarvis March and Quickhull ran roughly the same time, with Graham Scan starting to increase at a more rapid rate than both the Jarvis March and Quickhull, meaning that both Jarvis March and Quickhull are closer to their best case scenario (with a runtime of O(n)) and Graham Scan operates at O(nlogn).
* Points within a Triangle
  + Yes, this matches my theoretical analysis. Yet again the Graham Scan took longer than both the Jarvis March and the Quickhull. This is roughly a best case for both Jarvis March and Quickhull (meaning their runtime is approximately O(n)) and the average case for Graham Scan (meaning its runtime is approximately O(nlogn)).